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NOTES ON GEOGRAPHIC DISTRIBUTION

Mammalia, Lagomorpha, Leporidae, *Oryctolagus cuniculus* Linneaus, 1758: New record and its potential dispersal corridors for northern Mendoza, Argentina

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ABSTRACT: The introduction of exotic species can cause important changes in the structure and function of natural ecosystems. This note reports the introduction of the European rabbit, *Oryctolagus cuniculus*, into Villavicencio Natural Reserve in Mendoza, Argentina. Individuals were introduced from a breeding facility within the reserve. This study assessed the possible establishment of the species as well as its potential dispersal corridors. Our findings suggest that the rabbit could be using the riverbeds as dispersal corridors. We consider that *O. cuniculus* is in the establishment stage and can become a potential invader of new environments in the reserve and surrounding areas.

The introduction of exotic species can cause significant damage on native biota and ecosystems (Vitousek *et al.* 1997; Mooney and Cleland 2001). The invasion process has at least three stages: introduction, establishment and spread (Lockwood *et al.* 2008). Passing from one stage to another requires overcoming several ecological barriers. For example, a species has to pass through a geographic barrier to reach the introduction stage and then go across an environmental barrier to achieve establishment. The last barrier to the final stage is a dispersal barrier, where the species spreads into new areas away from the introduction sites. A species that surpasses all of these barriers and becomes widespread and abundant enough to cause some ecological or economic harm can be defined as an 'invasive species' (Lockwood *et al.* 2008).

The invasion process is difficult to predict and most species are not effective invaders. Williamson (1996) proposes that 10% of the introduced species successfully accomplish an invasion stage, although recent studies found that this percentage reaches 50% (Jeschke and Strayer 2005). However, in order to understand this process, it is necessary to know the date of introduction, the transport vector and pathways of the species as well as the propagule pressure (Lockwood *et al.* 2008).

The European rabbit, *Oryctolagus cuniculus* (Linnaeus, 1958), is native to the Iberian Peninsula and the south of France, and is one of the invasive species found in Argentina (Novillo and Ojeda 2008). It was first introduced into Argentina in 1880 in several Beagle Channel Islands, and then again in 1936 in the northern portion of Tierra del Fuego (Navas 1987). At present, the European rabbit is established in three regions: 1) Tierra del Fuego and Falkland islands; 2) southeast of Santa Cruz province (southern Patagonia region); and 3) southwest of Mendoza and Neuquén provinces (northern Patagonia). In the later, rabbits crossed through low passes in the Andean mountain range from adjacent areas of central Chile (Bonino and Soriguer 2009).

European rabbits are known as ecosystem engineers because they alter the distribution of soil resources through the construction of their warrens (Eldridge and Koen 2008), and produce important changes in plant species cover and richness (Eldridge and Myers 2001). They are also good seed dispersers, as in the case of exotic plant species such as the Opium poppy, *Papaver somniferum* (Fernández and Sáiz 2007) and of native species such as Litre (*Lithraea caustica*) (Castro *et al.* 2008).

In August 2006, four couples of rabbits were intentionally released in the Natural Reserve of Villavicencio (32°31' S - 69°1' W; Figure 1) in Mendoza, Argentina. These animals belonged to an internal breeding facility of this private reserve. In order to carry out studies on the ecology and impact of European rabbits to this new area, and to assess if management and control actions are needed, it is necessary to determine whether or not this species has actually established itself in this new area. The aim of this study was to assess the establishment of *O. cuniculus* in the Natural Reserve of Villavicencio and to identify its potential dispersal corridors.

The study was conducted in the Natural Reserve of Villavicencio between 2007 and 2010. The reserve has 62,000 ha and its altitudinal range from 900 to 3200 m a.s.l. Annual precipitation varies between 120 and 300 mm. The reserve protects three important phytogeographic biomes: Puna, Cardonal and Monte (Dalmasso *et al.* 1999). The aims of the reserve are to protect native flora and fauna, as well as the water resources within it (Roig and Martínez Carretero 1998). These biomes are fragile and their recovery is slow. The vegetation community is dominated by shrubs of the genera *Lycium*, *Baccharis*, *Artemisia* and *Adesmia*, and grasses of the genera *Stipa*, *Poa* and *Aristida*. The riverbeds are characterized by the presence of exotic plant species including *Rosa rubiginosa* and *Spartium junceum* (Dalmasso *et al.* 1999).

We set up 24 transects from the site of introduction on hillsides and riverbeds following the topography of the area.

The number of transects varied along the years, from 10 transects during 2007-2009 to 24 during 2010. Transects were walked once a year, during which the indirect presence of European rabbit through fresh evidence like fecal pellets within 5 m of either side of each transect was recorded. Rabbit pellets where identified by comparing the feces found to feces from the breeding facility. The European hare (*Lepus europaeus*) is also present in the study area, but the feces are easy to differentiate because of the shape, size and color. Rabbit feces are spherical with a little peak in one of its sides, dark brown coloration and 0.5 - 1 cm in diameter. Hares feces are also spherical but with their sides slightly flattened, are bigger (1.5 – 2 cm in diameter) and lighter (light brown) than the rabbit feces. However, the color of the feces depends on the species' diet in a particular place.

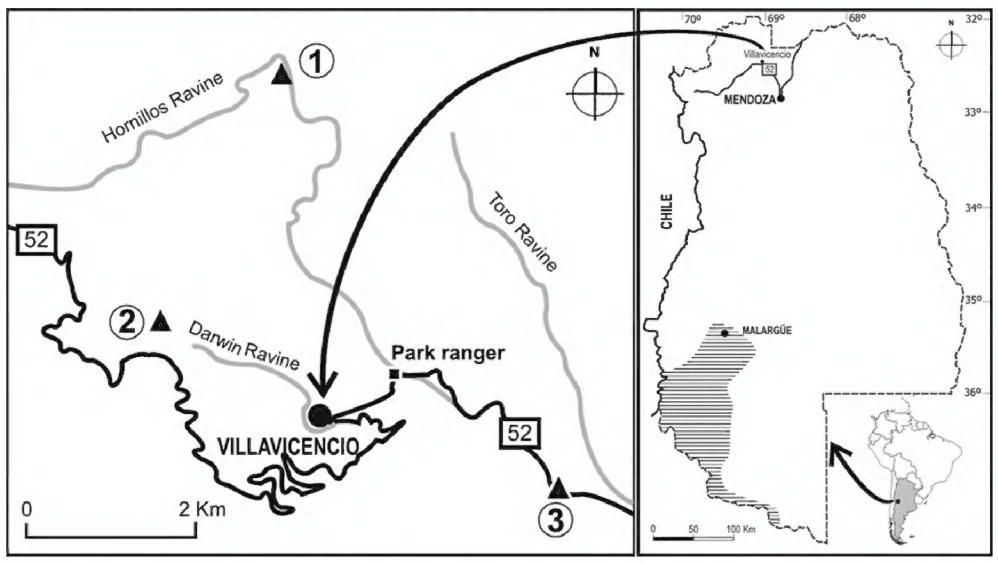

FIGURE 1. Distribution of European rabbit (*Oryctolagus cuniculus*) in Mendoza province (dashed line) and its potential dispersal corridors (1, 2, 3) in the Natural Reserve of Villavicencio.

The presence of rabbit signs varied according to the time elapsed since they were first introduced. During the first year of their introduction (2007), we only recorded the presence of *O. cuniculus* around the release site, occupying the tourist area and the forest dominated by exotic vegetation. During the remaining study period, we found no sign of rabbits near the tourist area or on hillside transects, but only found signs on riverbed transects. After two years (2008), we identified three potential dispersal corridors (Figure 1): Hornillos Ravine (northwest direction), Darwin Ravine (west direction) and the third path towards the Monte desert foothills (southeast direction). Based on the feces collected, the species reached a minimum distance of 6 km on the first corridor, a minimum distance of 3.5 km on the second corridor and in the third dispersal corridor, the minimum distance travelled was 4 km. After four years of introduction (2010), no fresh signs were found on the third potential dispersal corridor but were still present in the first and second corridors.

Despite the hunting pressure in the area, the continued presence of European rabbit signs may indicate that the species has indeed established in this area. The presence of rabbit signs only along riverbed transects could be explained by the influence of factors like vegetation, soil, and places with streams or higher moisture. The absence of signs from the third corridor could be because the Monte desert is an unfavorable habitat for the species due to its high degree of aridity. Bonino and Amaya (2004) found the same results in Neuquén and south of Mendoza provinces.

In summary, the European rabbit is established (in the second stage of invasion) in the Natural Reserve of Villavicencio. While the spread of this species appears to be slow in our study site compared with other records (Myers *et al.* 1994; Bonino and Soriguer 2009), this species could be considered a potential invader of new environments such as the Cardonal and Puna biomes. Furthermore, its background as an ecosystem engineer and its characteristics of being a rapid invader could allow this species to become an important factor of disturbance generating significant changes along the Andean mountain ranges of the region.

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